Fig. I   Block Diagram of Tree System

CDC= Complex
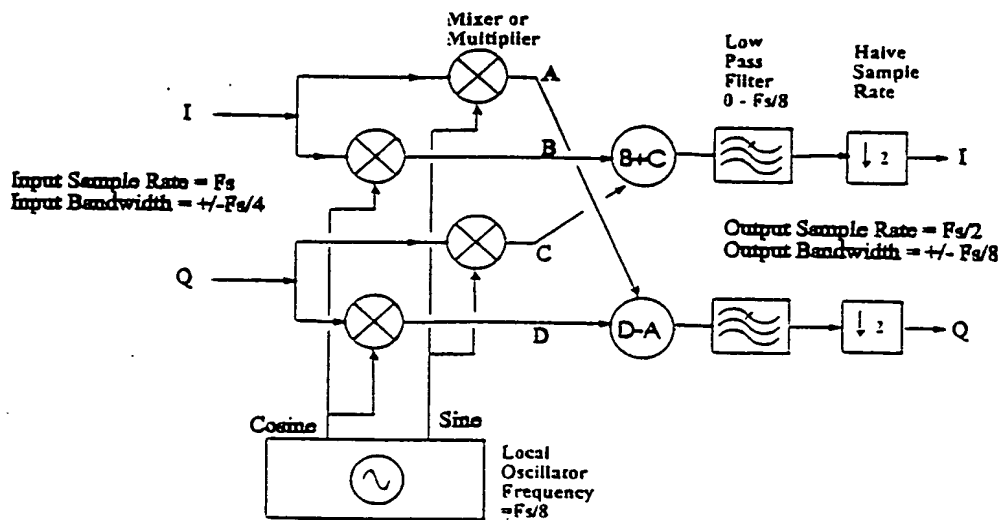   Down-Converter

CUC= Complex
        Up-Converter
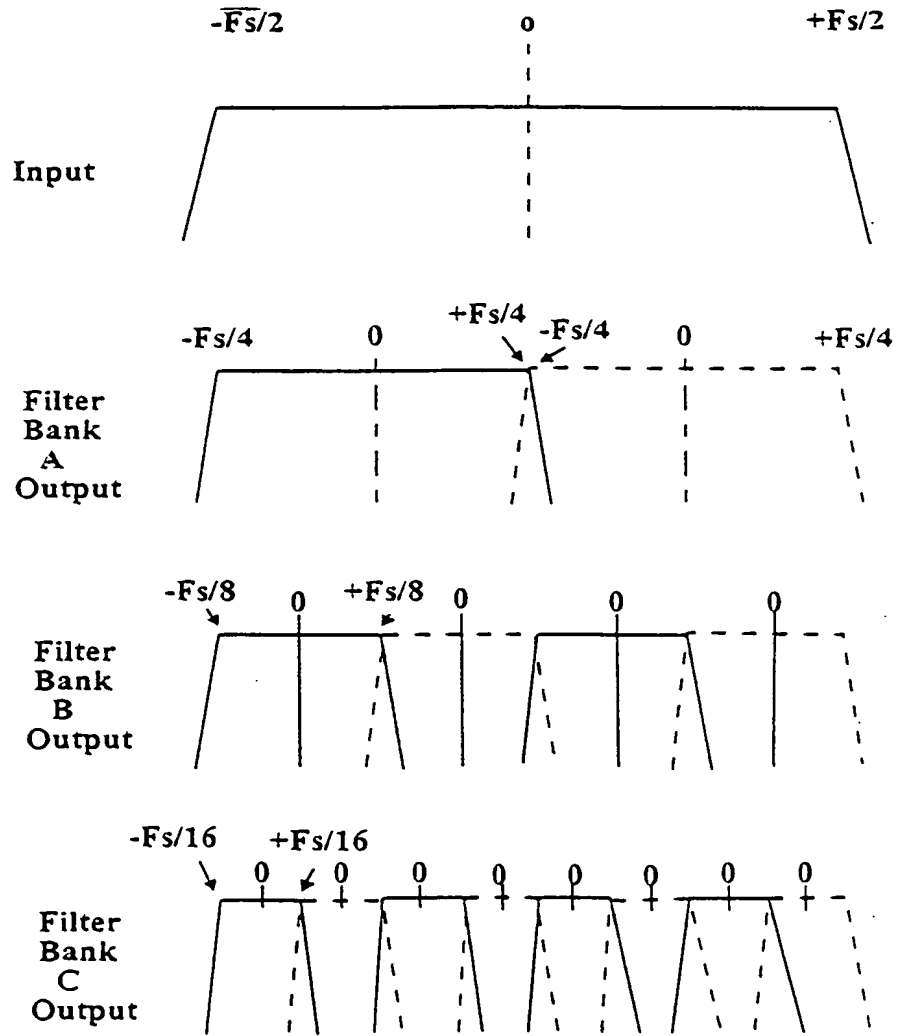
Fig. 2 Frequency Band Splitting

Fig. 3   Complex Down-Converter (CDC)
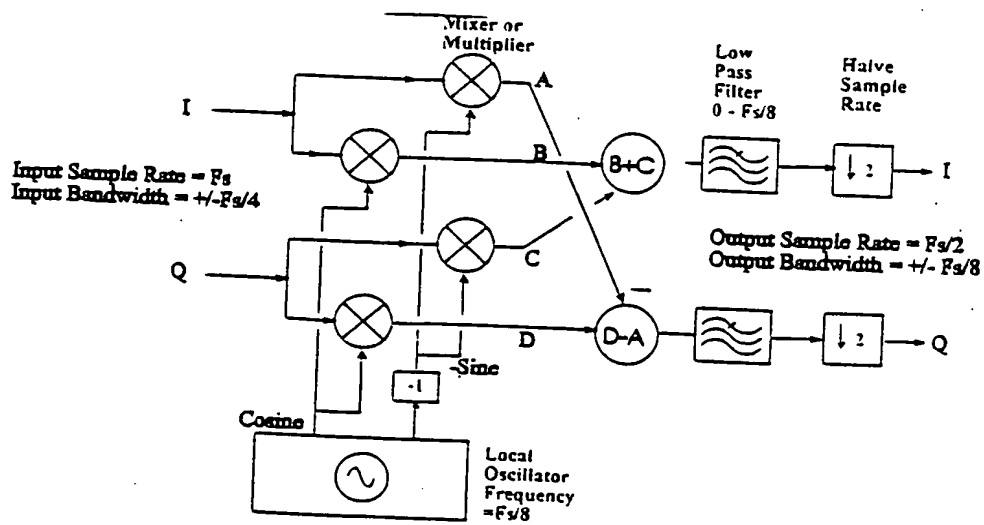
Fig. 4   Complex Up-Converter (CUC)
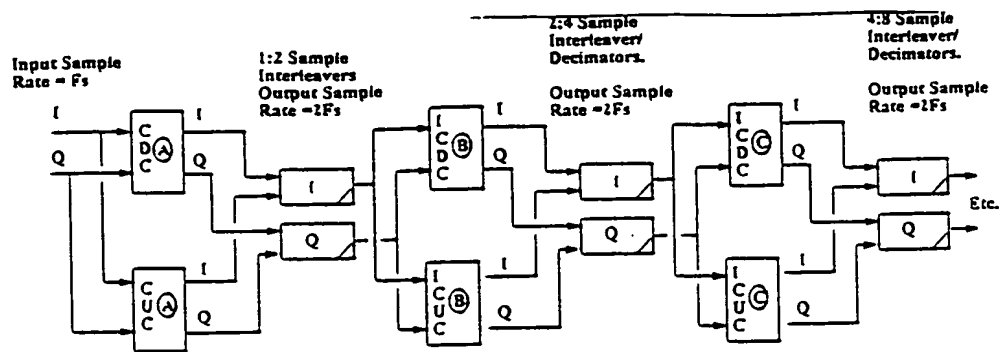
Figure 5   Block Diagram of Interleaved System
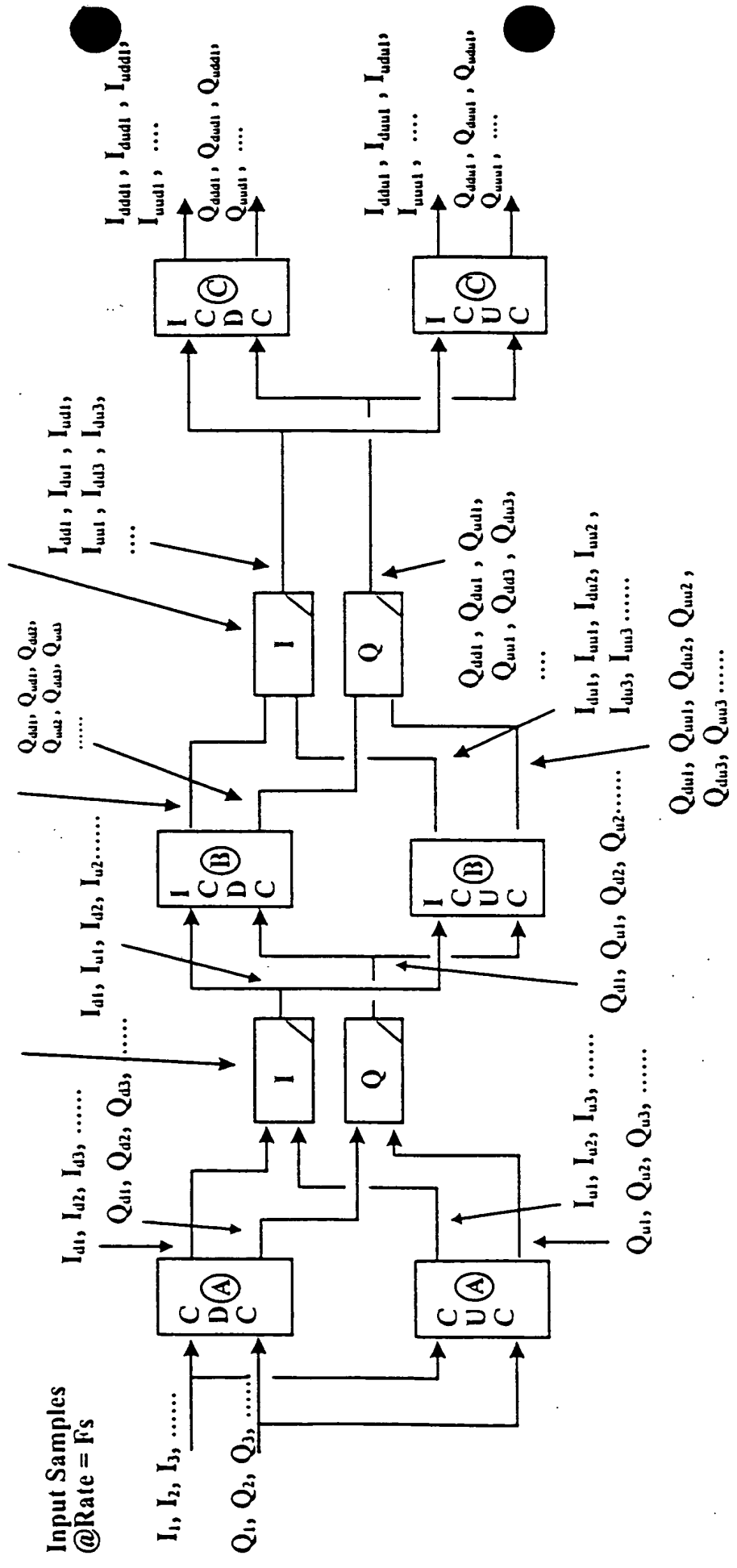
Figure 6 Detail of Interleavers
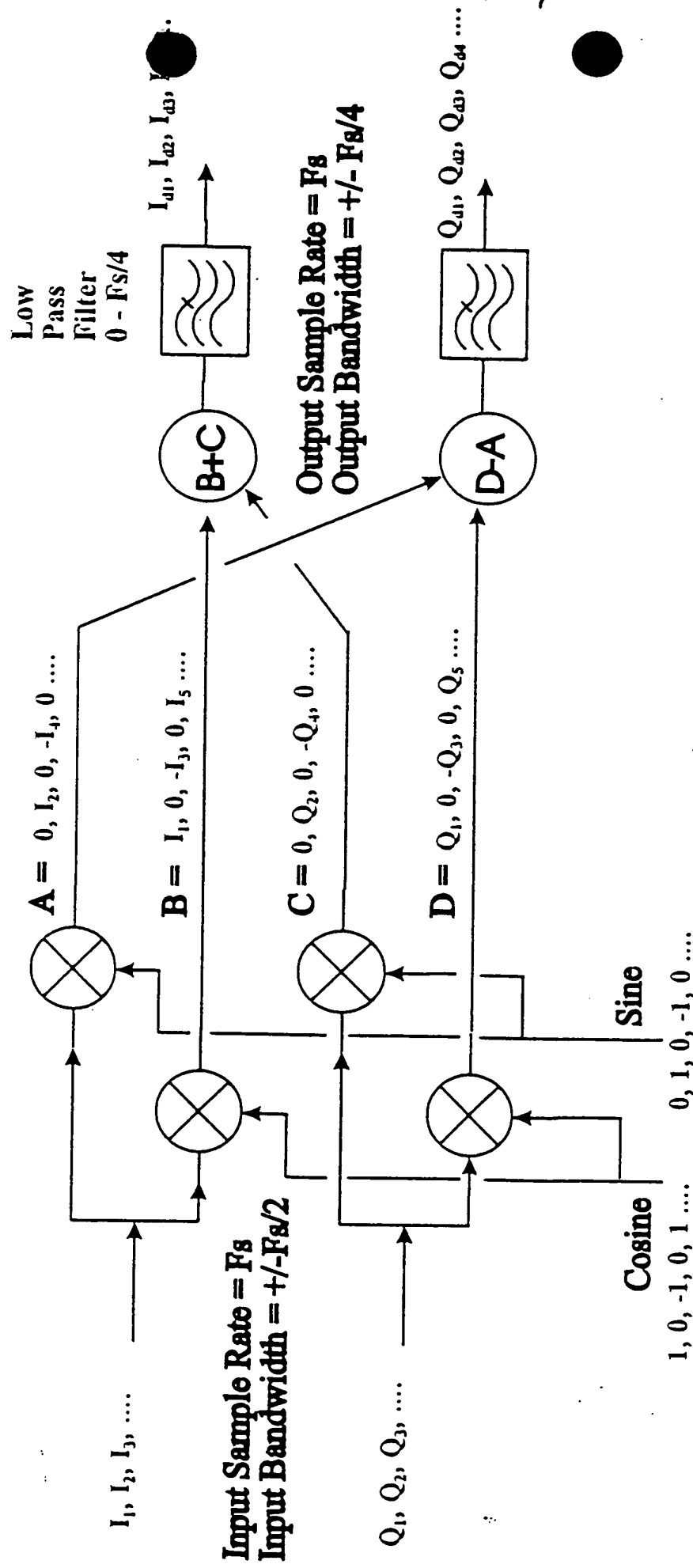
Fig. 7 BASIC CDC(A) ARCHITECTURE
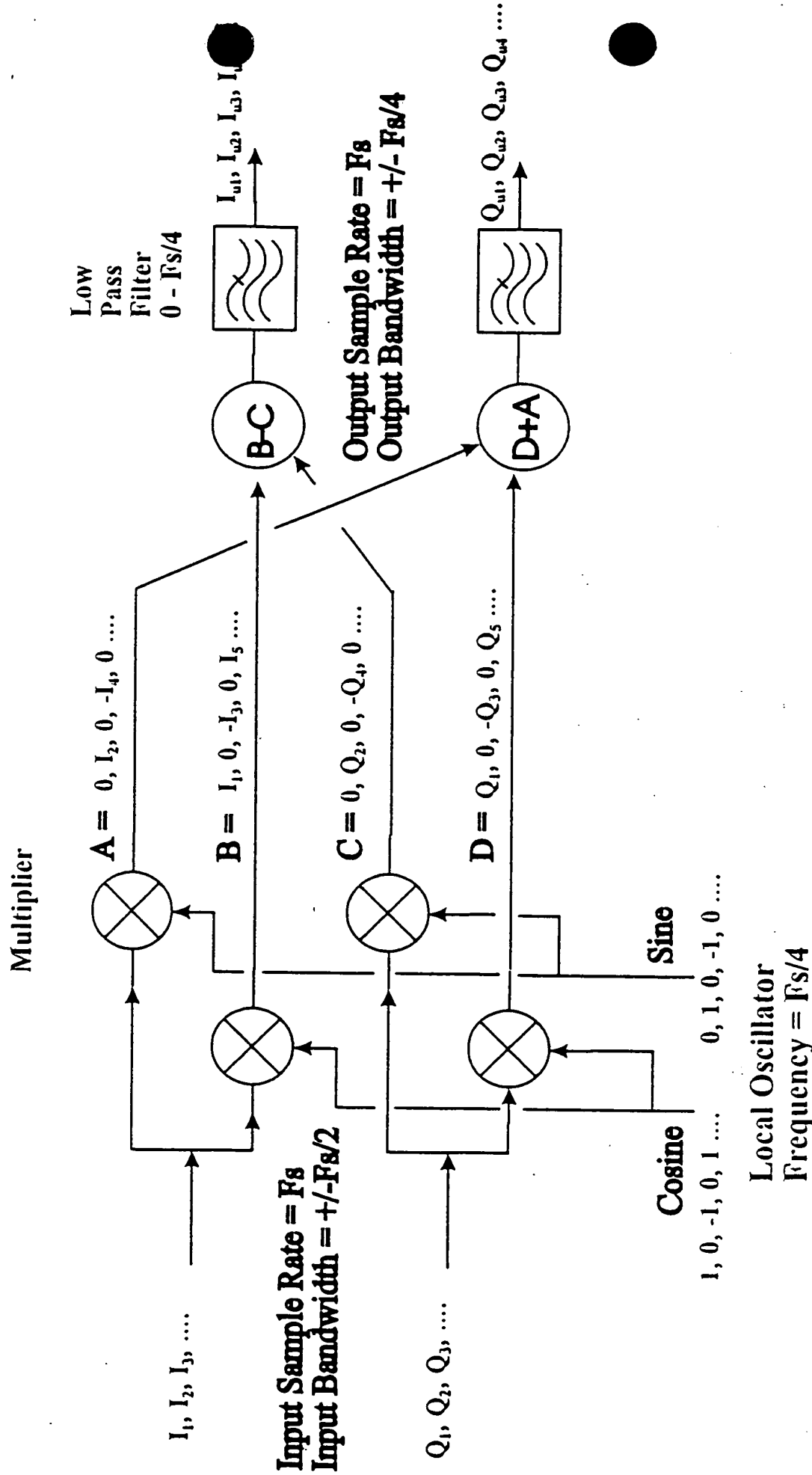
Fig. 8 BASIC CUC(A) ARCHITECTURE

EG10760 SER NO 60

Input Sample Rate = Fs/2
Input Bandwidth = +/-Fs/2

$I_1, I_3, I_5 \ldots$

$I_2, I_4, I_6 \ldots$

$Q_1, Q_3, Q_5 \ldots$

$Q_2, Q_4, Q_6 \ldots$

$I_1, Q_2, I_3, Q_4 \ldots$

$Q_1, I_2, Q_3, I_4 \ldots$

Low
Pass
Filter
0 – Fs/4

$1, 1, -1, -1, 1$

$1, -1, -1, 1, 1$

$I_{d1}, I_{d2}, I_{d3}, I_{d4} \ldots$

$Q_{d1}, Q_{d2}, Q_{d3}, Q_{d4} \ldots$

Output Sample Rate = Fs
Output Bandwidth = +/- Fs/4

Fig. 9 MODIFIED CDC(A) ARCHITECTURE

Input Sample Rate = Fs/2
Input Bandwidth = +/-Fs/2

$I_1, I_3, I_5 \ldots$

$I_2, I_4, I_6 \ldots$

$Q_1, Q_3, Q_5 \ldots$

$Q_2, Q_4, Q_6 \ldots$

$I_1, Q_2, I_3, Q_4 \ldots$

$1, -1, -1, 1, 1 \ldots$

Low
Pass
Filter
0 – Fs/4

$I_{d1}, I_{d2}, I_{d3}, I_{d4} \ldots$

$Q_1, I_2, Q_3, I_4 \ldots$

$1, 1, -1, -1, 1 \ldots$

$Q_{d1}, Q_{d2}, Q_{d3}, Q_{d4} \ldots$

Output Sample Rate = Fs
Output Bandwidth = +/- Fs/4
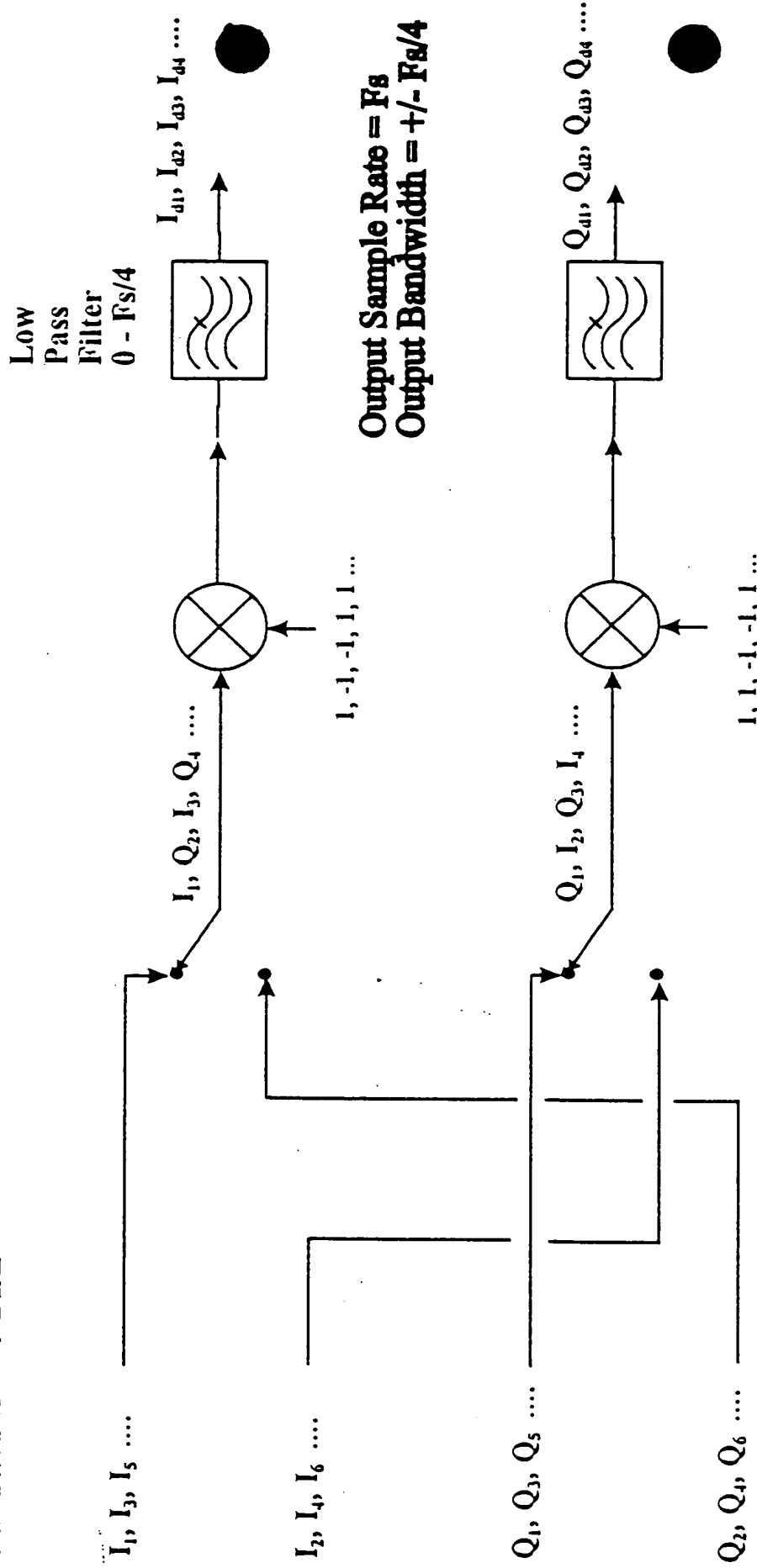
Fig. 10 MODIFIED CUC(A) ARCHITECTURE

Fig. 11 COMBINED CDC(A) & CUC(A) ARCHITECTURE

Multiplier

Interleaved Samples

$I_{d1}, I_{u1}, I_{d2}, I_{u2}, \ldots$

$Q_{d1}, Q_{u1}, Q_{u2}, \ldots$

Input Sample Rate = 2Fs
Input Bandwidth = +/- Fs/4

Local Oscillator
Frequency = Fs/8

A

B

C

D

Sine

Cosine

Halve
Sample
Rate

Low
Pass
Filter
0 - Fs/8

B+C

D-A

$\downarrow 2$

$\downarrow 2$

$I_{d1}, I_{u1}, I_{dd1}, I_{ud2} \ldots$

$Q_{dd1}, Q_{ud1}, Q_{dd2}, Q_{ud2} \ldots$

Output Sample Rate = Fs
Output Bandwidth = +/- Fs/8

$Cos_{odd} = 1, k, 0, -k, -1, -k, 0, k, \ldots$
$Cos_{even} = 1, k, 0, -k, -1, -k, 0, k, \ldots$

$Sin_{odd} = 0, k, 1, k, 0, -k, -1, -k, \ldots$
$Sin_{even} = 0, k, 1, k, 0, -k, 1, -k, \ldots$

$A_{odd} = 0, kI_{d2}, I_{d3}, kI_{d4}, 0, -kI_{d6}, -I_{d7}, -kI_{d8} \ldots$
$A_{even} = 0, kI_{u2}, I_{u3}, kI_{u4}, 0, -kI_{u6}, -I_{u7}, -kI_{u8} \ldots$

$B_{odd} = I_{d1}, kI_{d2}, 0, -kI_{d4}, -I_{d5}, -kI_{d6}, 0, kI_{d8} \ldots$
$B_{even} = I_{u1}, kI_{u2}, 0, -kI_{u4}, -I_{u5}, -kI_{u6}, 0, kI_{u8} \ldots$

$C_{odd} = 0, kQ_{d2}, Q_{d3}, kQ_{d4}, 0, -kQ_{d6}, -Q_{d7}, -kQ_{d8} \ldots$
$C_{even} = 0, kQ_{u2}, Q_{u3}, kQ_{u4}, 0, -kQ_{u6}, -Q_{u7}, -kQ_{u8} \ldots$

$D_{odd} = Q_{d1}, kQ_{d2}, 0, -kQ_{d4}, -Q_{d5}, -kQ_{d6}, 0, kQ_{d8} \ldots$
$D_{even} = Q_{u1}, kQ_{u2}, 0, -kQ_{u4}, -Q_{u5}, -kQ_{u6}, 0, kQ_{u8} \ldots$

Fig. 12 BASIC ICDC(B) ARCHITECTURE

TOPC3D = E/9H-/60

Multiplier

Halve Sample Rate

Low Pass Filter 0 - Fs/8

Output Sample Rate = Fs
Output Bandwidth = +/- Fs/8

$I_{du1}, I_{uu1}, I_{du2}, I_{uu2} \ldots$

Interleaved Samples

$I_{d1}, I_{u1}, I_{d2}, I_{u2}, \ldots$

Input Sample Rate = 2Fs
Input Bandwidth = +/-Fs/4

$Q_{d1}, Q_{u1}, Q_{d2}, \ldots$

$Q_{du1}, Q_{uu1}, Q_{du2}, Q_{uu2} \ldots$

Local Oscillator
Frequency = Fs/8

Sine

Cosine

A

B

C

D

B-C

D+A

$Cos_{odd} = 1, k, 0, -k, -1, -k, 0, k, \ldots$
$Cos_{even} = 1, k, 0, -k, -1, -k, 0, k, \ldots$

$Sin_{odd} = 0, k, 1, k, 0, -k, -1, -k, \ldots$
$Sin_{even} = 0, k, 1, k, 0, -k, 1, -k, \ldots$

$A_{odd} = 0, kI_{d2}, I_{d3}, kI_{d4}, 0, -kI_{d6}, -I_{d7}, -kI_{d8} \ldots$
$A_{even} = 0, kI_{u2}, I_{u3}, kI_{u4}, 0, -kI_{u6}, -I_{u7}, -kI_{u8} \ldots$

$B_{odd} = I_{d1}, kI_{d2}, 0, -kI_{d4}, -I_{d5}, -kI_{d6}, 0, kI_{d8} \ldots$
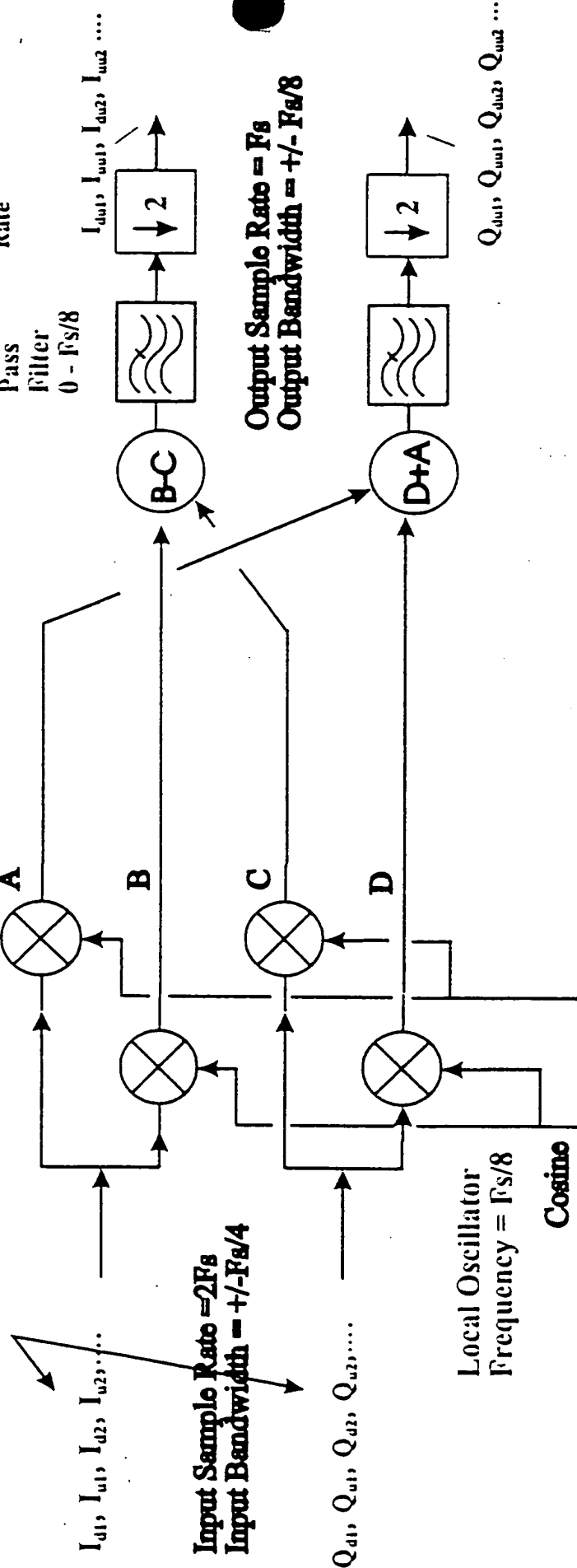$B_{even} = I_{u1}, kI_{u2}, 0, -kI_{u4}, -I_{u5}, -kI_{u6}, 0, kI_{u8} \ldots$

$C_{odd} = 0, kQ_{d2}, Q_{d3}, kQ_{d4}, 0, -kQ_{d6}, -Q_{d7}, -kQ_{d8} \ldots$
$C_{even} = 0, kQ_{u2}, Q_{u3}, kQ_{u4}, 0, -kQ_{u6}, -Q_{u7}, -kQ_{u8} \ldots$

$D_{odd} = Q_{d1}, kQ_{d2}, 0, -kQ_{d4}, -Q_{d5}, -kQ_{d6}, 0, kQ_{d8} \ldots$
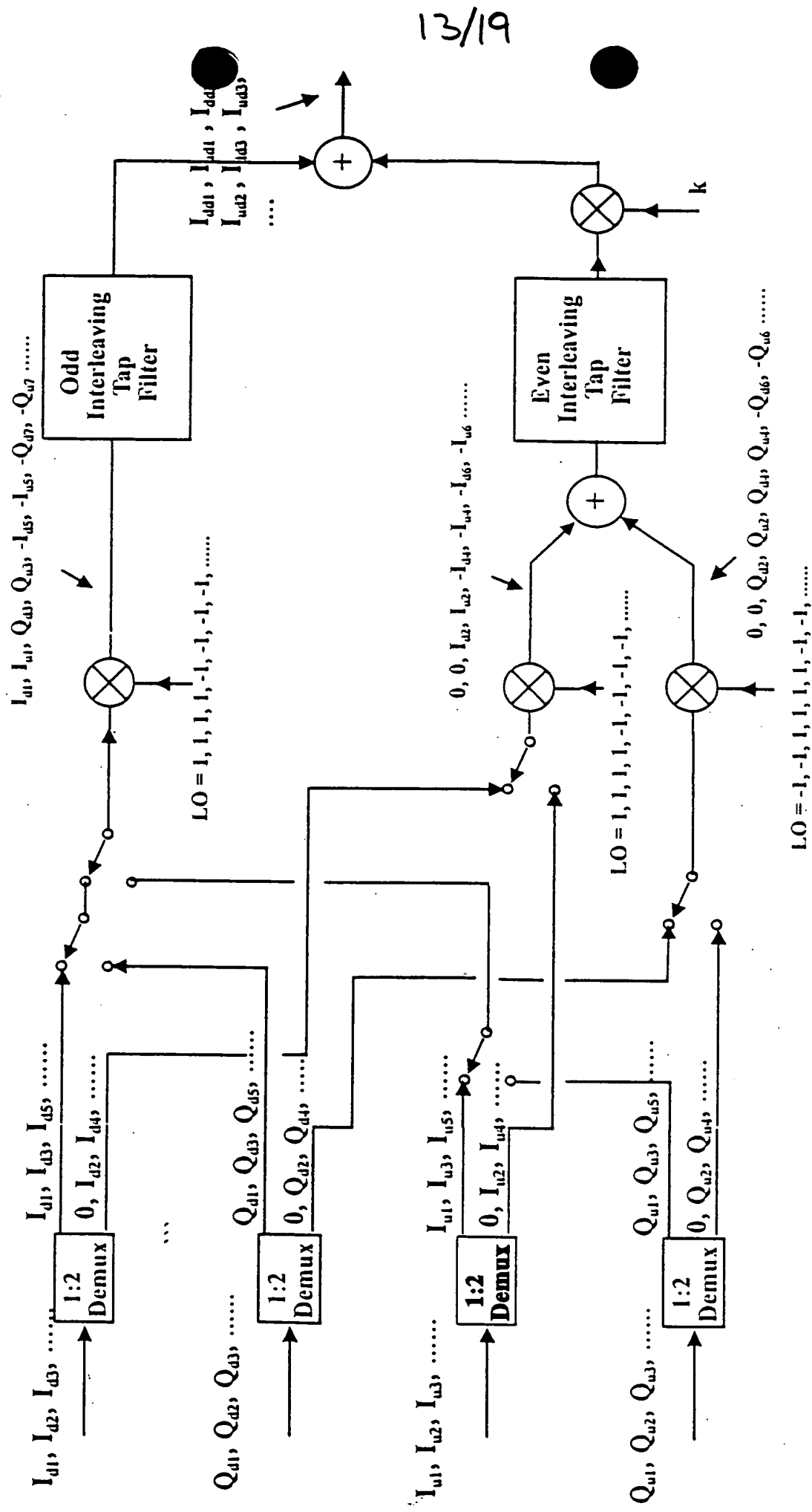$D_{even} = Q_{u1}, kQ_{u2}, 0, -kQ_{u4}, -Q_{u5}, -kQ_{u6}, 0, kQ_{u8} \ldots$

Fig. 13 BASIC ICUC(B) ARCHITECTURE

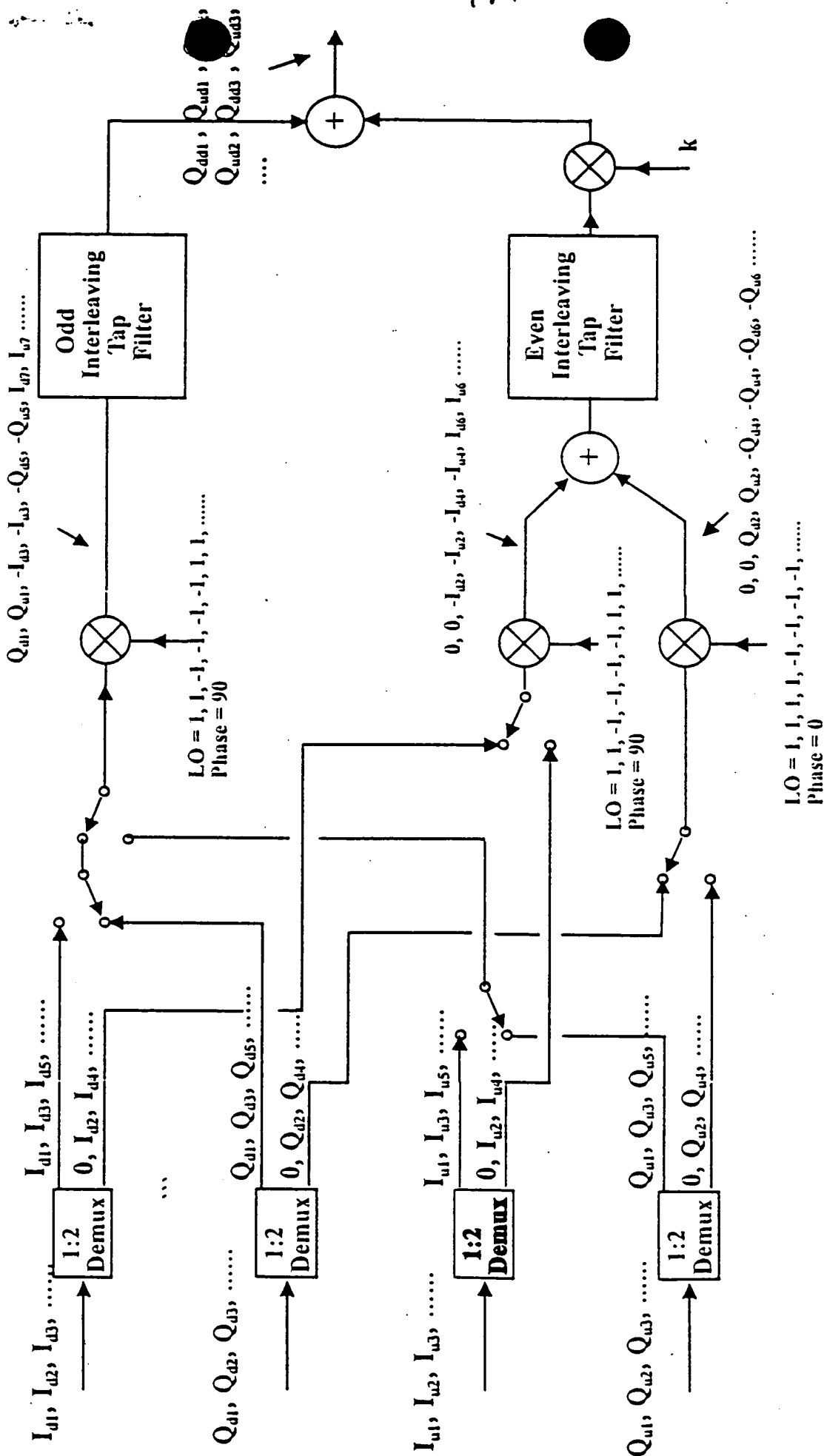Figure 14 Simplified ICDC(B), I channel Only

Figure 15 Simplified ICDC(B), Q channel Only
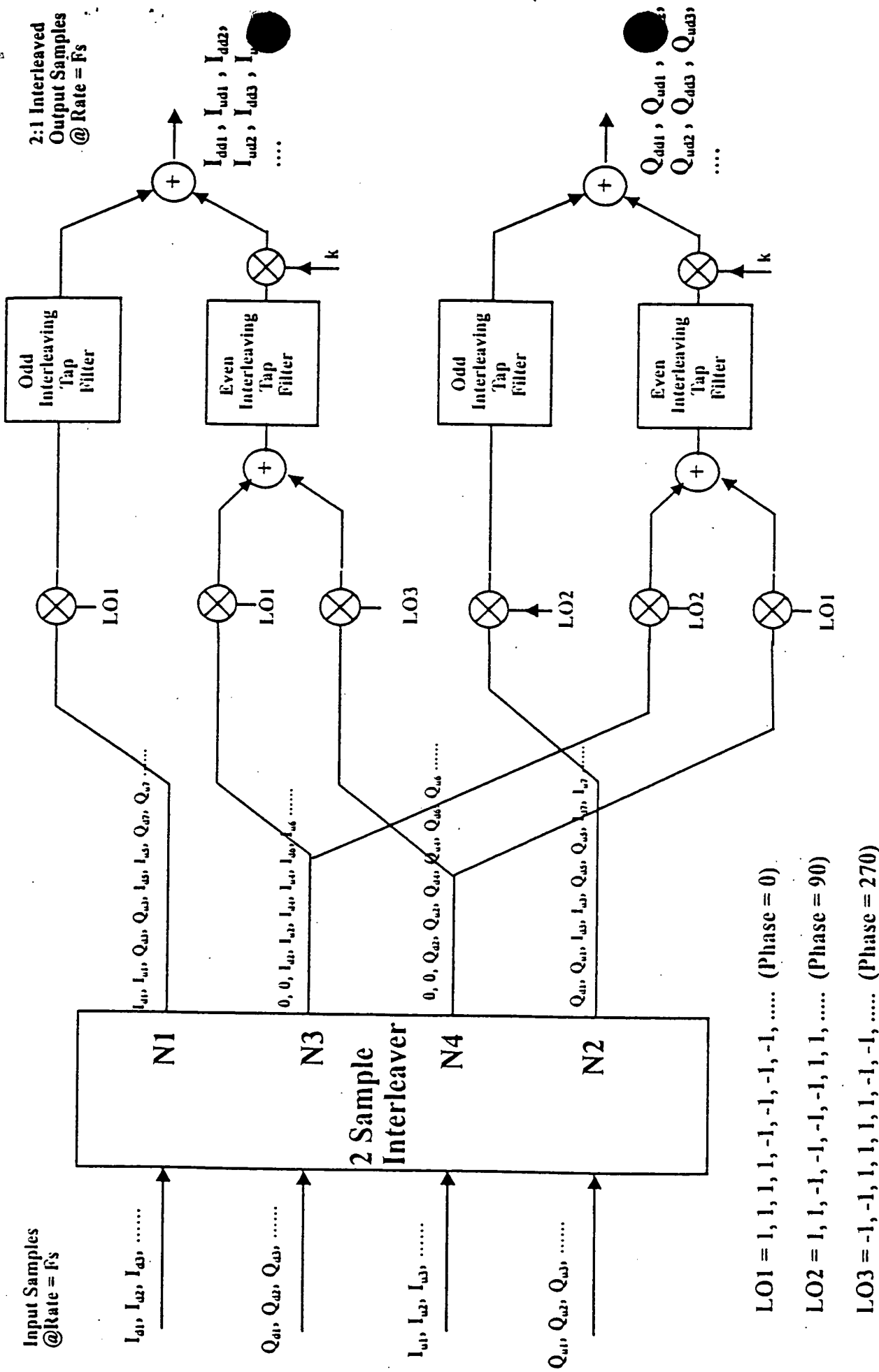
Figure 16 Simplified ICDC(B), Combined I & Q Channels

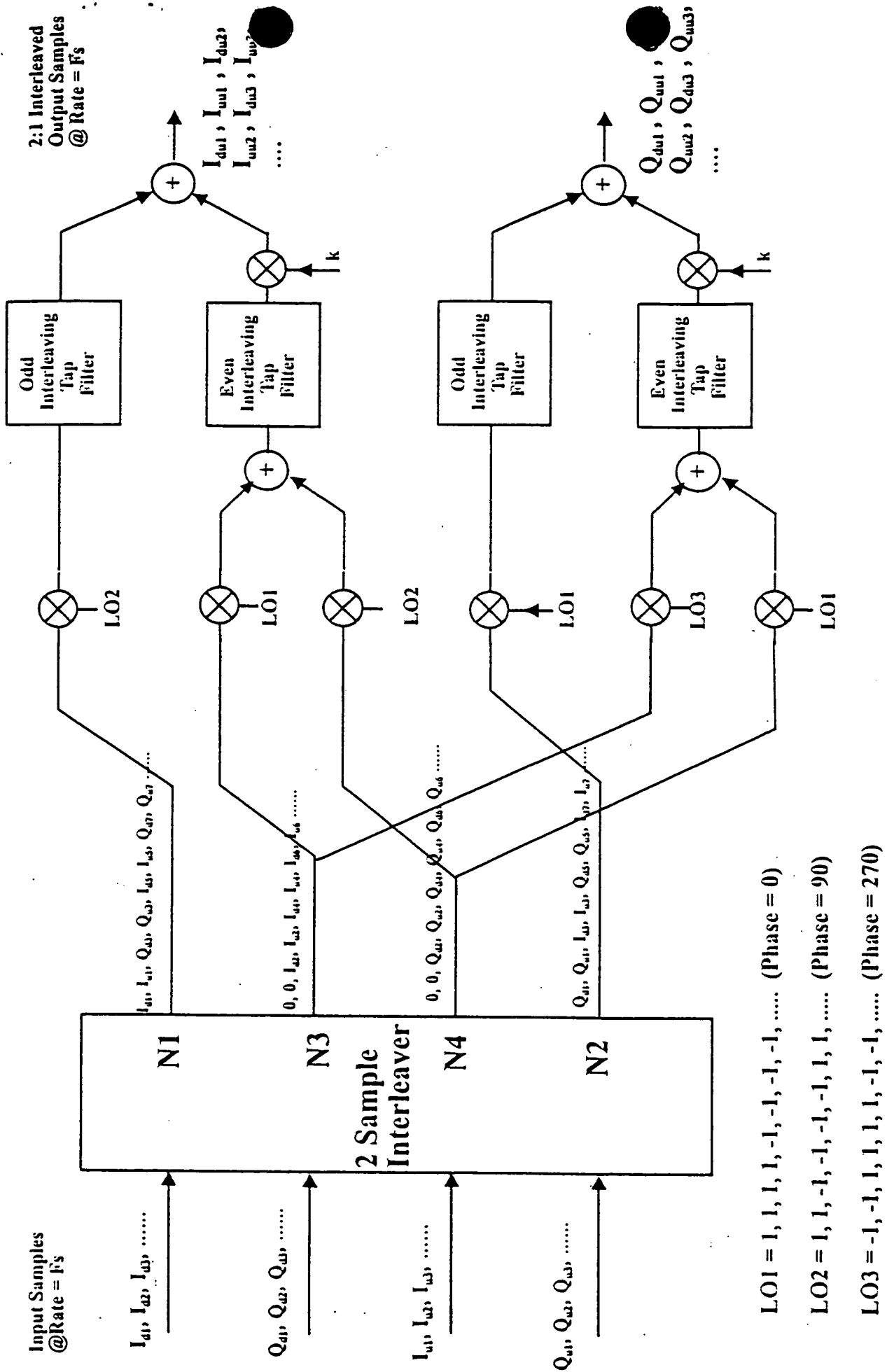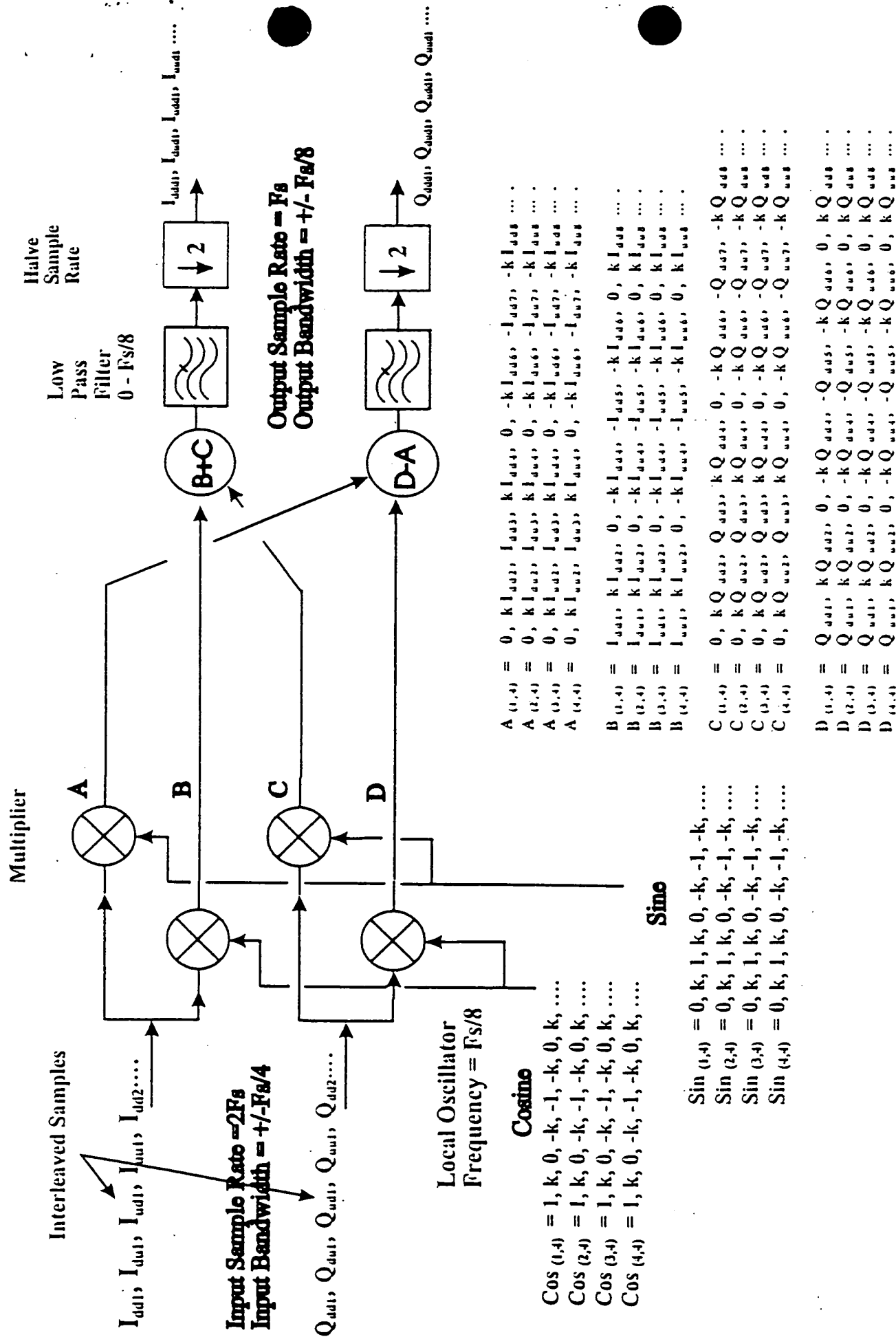Figure 17 Simplified ICUC(B), Combined I & Q Channels

Halve Sample Rate

Low Pass Filter 0 - Fs/8

Output Sample Rate = Fs
Output Bandwidth = +/- Fs/8

Multiplier

A

B

C

D

Interleaved Samples

$I_{dd1}, I_{uu1}, I_{dd1}, I_{uu1}, I_{dd2}, \ldots$

Input Sample Rate = 2Fs
Input Bandwidth = +/- Fs/4

$Q_{dd1}, Q_{uu1}, Q_{uu1}, Q_{uu2}, \ldots$

Local Oscillator Frequency = Fs/8

B+C

D-A

↓2

↓2

$I_{dd1}, I_{dd1}, I_{udd1}, \ldots$

$Q_{dd1}, Q_{uu1}, Q_{udd1}, Q_{uu1}, \ldots$

Cosine

$Cos_{(1,s)} = 1, k, 0, -k, -1, -k, 0, k, \ldots$
$Cos_{(2,s)} = 1, k, 0, -k, -1, -k, 0, k, \ldots$
$Cos_{(3,s)} = 1, k, 0, -k, -1, -k, 0, k, \ldots$
$Cos_{(4,s)} = 1, k, 0, -k, -1, -k, 0, k, \ldots$

Sine

$Sin_{(1,s)} = 0, k, 1, k, 0, -k, -1, -k, \ldots$
$Sin_{(2,s)} = 0, k, 1, k, 0, -k, -1, -k, \ldots$
$Sin_{(3,s)} = 0, k, 1, k, 0, -k, -1, -k, \ldots$
$Sin_{(4,s)} = 0, k, 1, k, 0, -k, -1, -k, \ldots$

$A_{(1,s)} = 0, kI_{dd2}, I_{dd3}, kI_{dd3}, 0, -kI_{dd5}, -I_{dd7}, -kI_{dd7} \ldots$
$A_{(2,s)} = 0, kI_{dd2}, I_{dd3}, kI_{dd3}, 0, -kI_{dd5}, -I_{dd6}, -kI_{dd7} \ldots$
$A_{(3,s)} = 0, kI_{dd2}, I_{dd3}, kI_{dd3}, 0, -kI_{dd4}, -I_{dd7}, -kI_{dd7} \ldots$
$A_{(4,s)} = 0, kI_{dd2}, I_{dd3}, kI_{dd3}, 0, -kI_{dd4}, -I_{dd7}, -kI_{dd7} \ldots$

$B_{(1,s)} = I_{dd1}, kI_{dd3}, 0, -kI_{dd3}, -I_{dd5}, -kI_{dd5}, 0, kI_{dd6} \ldots$
$B_{(2,s)} = I_{dd1}, kI_{dd2}, 0, -kI_{dd3}, -I_{dd5}, -kI_{dd5}, 0, kI_{dd6} \ldots$
$B_{(3,s)} = I_{dd1}, kI_{dd2}, 0, -kI_{dd3}, -I_{dd5}, -kI_{dd5}, 0, kI_{dd6} \ldots$
$B_{(4,s)} = I_{dd1}, kI_{dd2}, 0, -kI_{dd3}, -I_{dd5}, -kI_{dd5}, 0, kI_{dd6} \ldots$

$C_{(1,s)} = 0, kQ_{dd2}, Q_{dd3}, kQ_{dd3}, 0, -kQ_{dd5}, -Q_{dd7}, -kQ_{dd7} \ldots$
$C_{(2,s)} = 0, kQ_{dd2}, Q_{dd3}, kQ_{dd3}, 0, -kQ_{dd5}, -Q_{dd7}, -kQ_{dd7} \ldots$
$C_{(3,s)} = 0, kQ_{dd2}, Q_{dd3}, kQ_{dd3}, 0, -kQ_{dd5}, -Q_{dd7}, -kQ_{dd7} \ldots$
$C_{(4,s)} = 0, kQ_{dd2}, Q_{dd3}, kQ_{dd3}, 0, -kQ_{dd5}, -Q_{dd7}, -kQ_{dd7} \ldots$

$D_{(1,s)} = Q_{dd1}, kQ_{dd3}, 0, -kQ_{dd3}, -Q_{dd5}, -kQ_{dd5}, 0, kQ_{dd6} \ldots$
$D_{(2,s)} = Q_{dd1}, kQ_{dd3}, 0, -kQ_{dd3}, -Q_{dd5}, -kQ_{dd5}, 0, kQ_{dd6} \ldots$
$D_{(3,s)} = Q_{dd1}, kQ_{dd3}, 0, -kQ_{dd3}, -Q_{dd5}, -kQ_{dd5}, 0, kQ_{dd6} \ldots$
$D_{(4,s)} = Q_{dd1}, kQ_{dd3}, 0, -kQ_{dd3}, -Q_{dd5}, -kQ_{dd5}, 0, kQ_{dd6} \ldots$

Fig. 18 BASIC ICDC(C) ARCHITECTURE
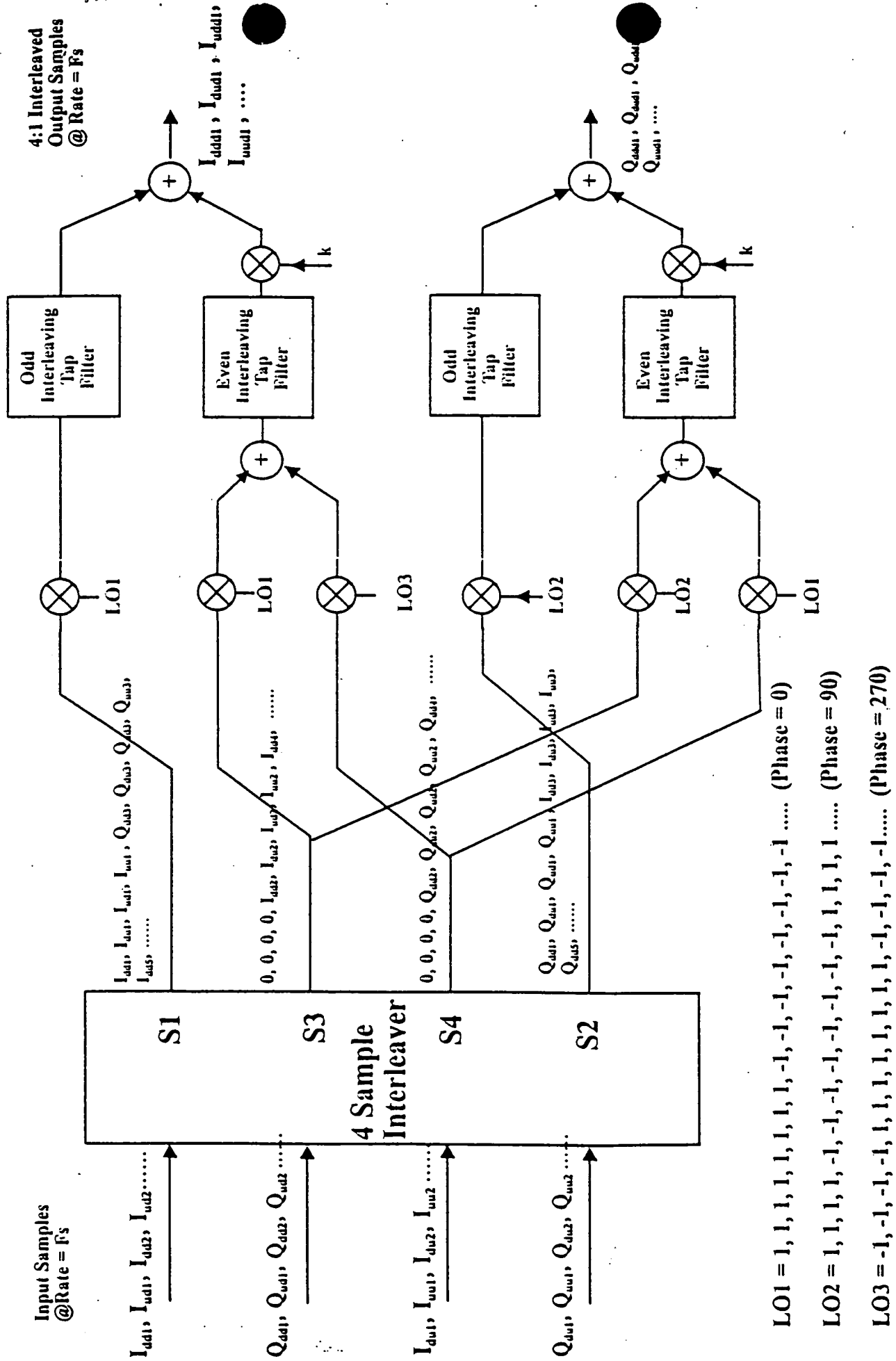
Figure 19 Simplified ICDC(C), Combined I & Q Channels

LO1 = 1, 1, 1, 1, 1, 1, 1, 1, -1, -1, -1, -1, -1, -1, -1, -1 ..... (Phase = 0)

LO2 = 1, 1, 1, 1, -1, -1, -1, -1, -1, -1, -1, -1, 1, 1, 1, 1 ..... (Phase = 90)

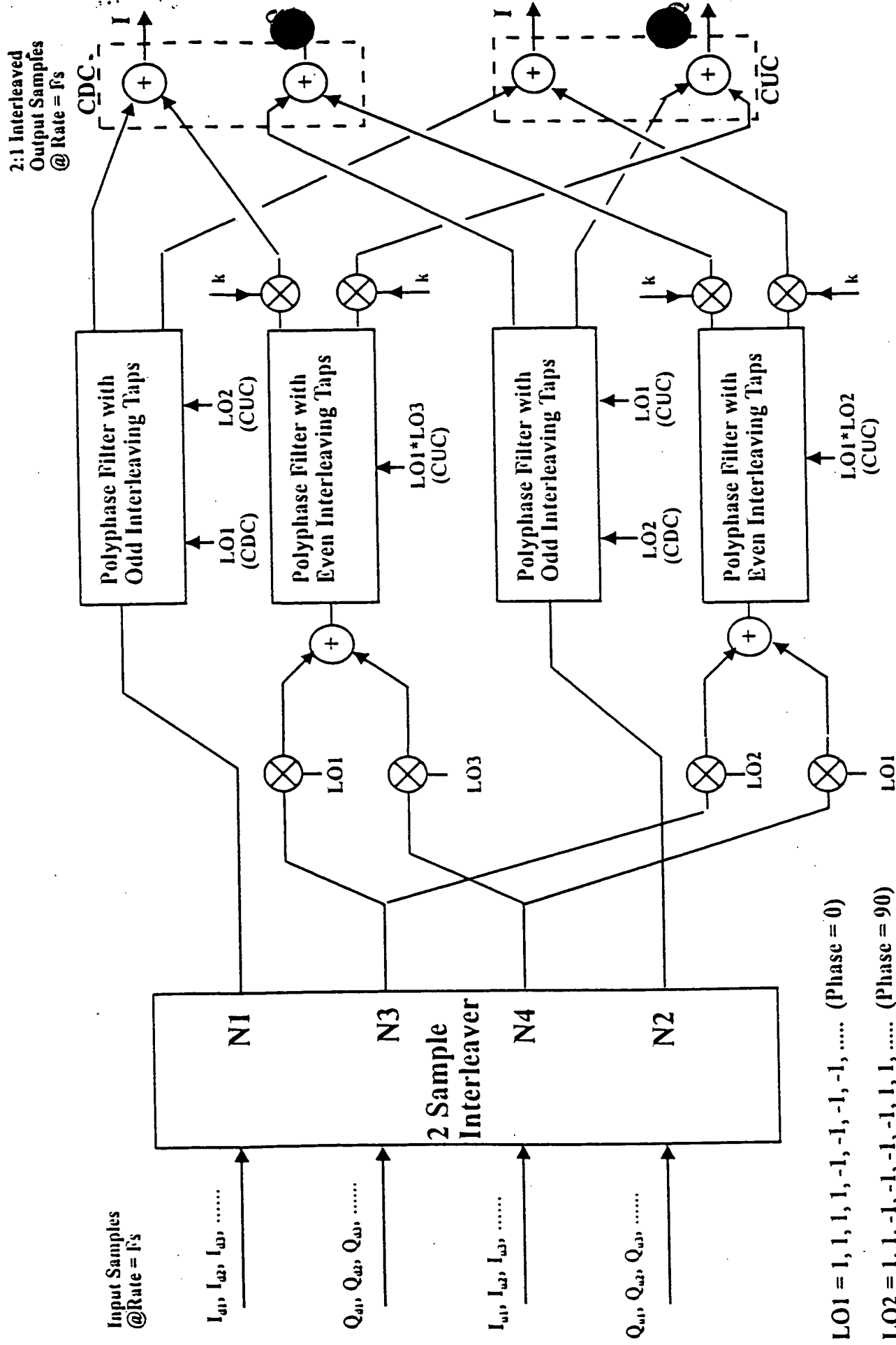LO3 = -1, -1, -1, -1, 1, 1, 1, 1, 1, 1, 1, 1, -1, -1, -1, -1..... (Phase =270)

Figure 20—Combined ICDC(B) / ICUC(B) With Polyphase Filters

LO1 = 1, 1, 1, 1, -1, -1, -1, -1, ...   (Phase = 0)

LO2 = 1, 1, -1, -1, -1, -1, 1, 1, ...   (Phase = 90)

LO3 = -1, -1, 1, 1, 1, 1, -1, -1, ...   (Phase = 270)